Center for Space Power and Advanced Electronics
Auburn University

Dr. Dan Deis
Manager of Engineering Science

Dr. Richard Hopkins
Manager of Electro-Optical Materials

Westinghouse Science and Technology Center

VALUE OF PARTICIPATION IN A CCDS TO AN INDUSTRIAL PARTNER

Dr. D. W. Deis

Dr. R. H. Hopkins

Westinghouse Science & Technology Center

Member of
NASA/Auburn University CCDS;
Center for Space Power and Advanced Electronics

NASA Office of Commercial Projects
Washington, DC
May 14, 1991

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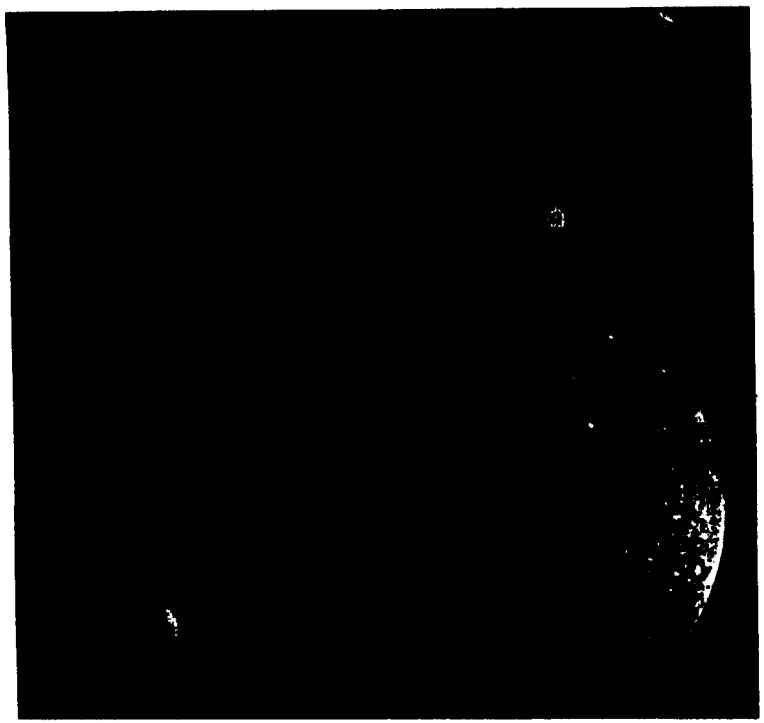
Westinghouse Is Involved In Space Activities: Its Commercial Activities Are Expanding As A Result Of Its CCDS Participation



- Space Division
- Commercial & Civil Space Dept.
- Science & Technology Center
- NASA CCDS's

The Westinghouse Space Division Applies Its Advanced Electronic Capability to the Analysis, Design, Development Production and Support of Space Related Missions

DMSP (Block VI Operational Line Scan (OLS) systems combine sensors, on-board data processing and broad-band digital recording to provide wide dynamic range imagery. Block V sensors have successfully demonstrated many years of on-orbit continuous operation.

- Earth Observation Sensors
- Control and Data Management
- Signal Processing
- Space Defense

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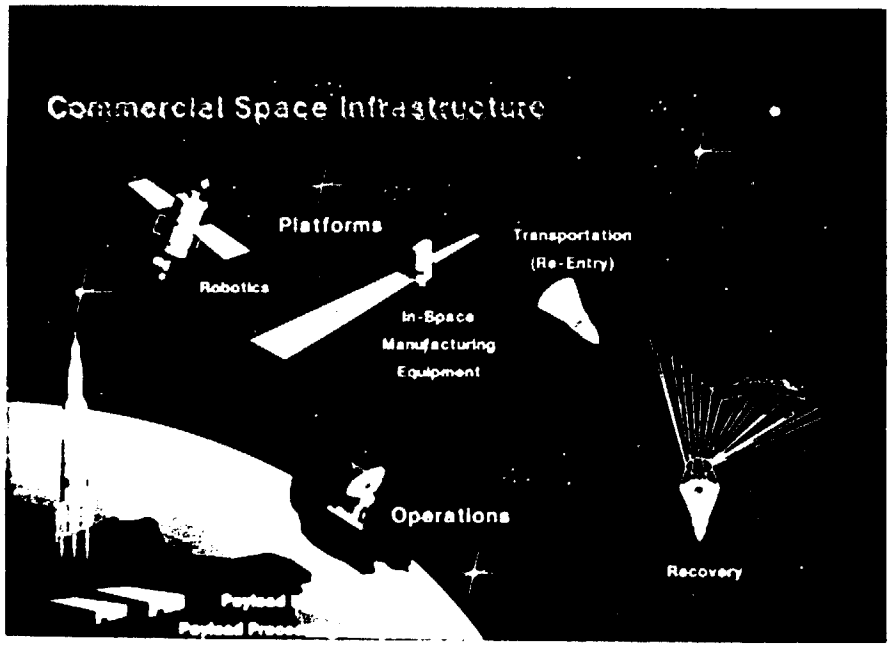
The Westinghouse Commercial & Civil Space Department Is Committed to Development the Infrastructure for Low Cost Access to Space



- Responsible for the Systems Engineering and Service Module for the COMET project.
- Operates Astro Tech for payload processing.
- Will actively pursue all aspects of commercial launch, on-orbit services, and recovery.
- Maintains active interactions with several CCDS's.

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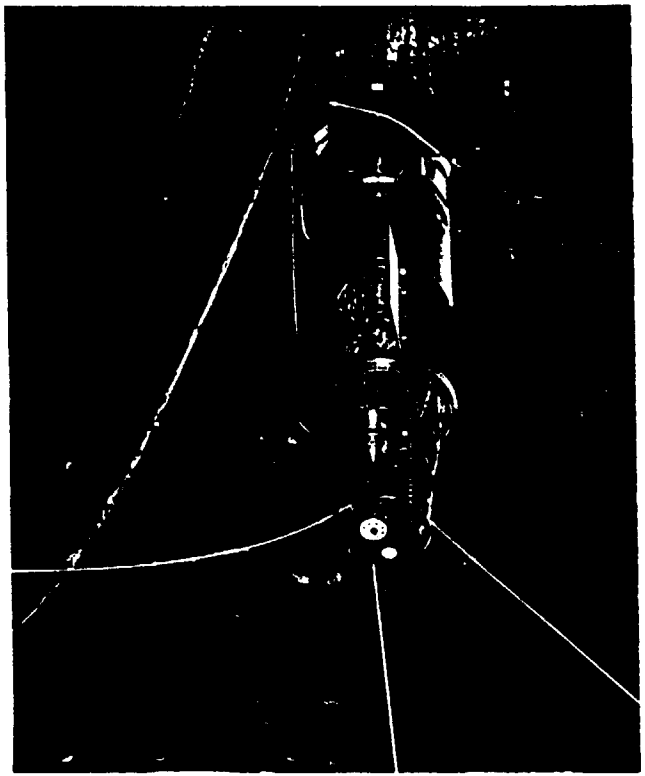
The Westinghouse Science & Technology Center Develops Products & Technologies for Westinghouse Divisions



Major Space Activities

- SPEAR Program
- Hyper-Conductor Generator
- TEM-Pump for SP-100
- Space Furnaces
- SMES Program
- Participation in CCDS's
  - Auburn
  - Clarkson

Westinghouse, In Conjunction With The Auburn CCDS, Is Developing Space Related Products and Technologies

Products: Intelligent fault protection system based on neural network technology

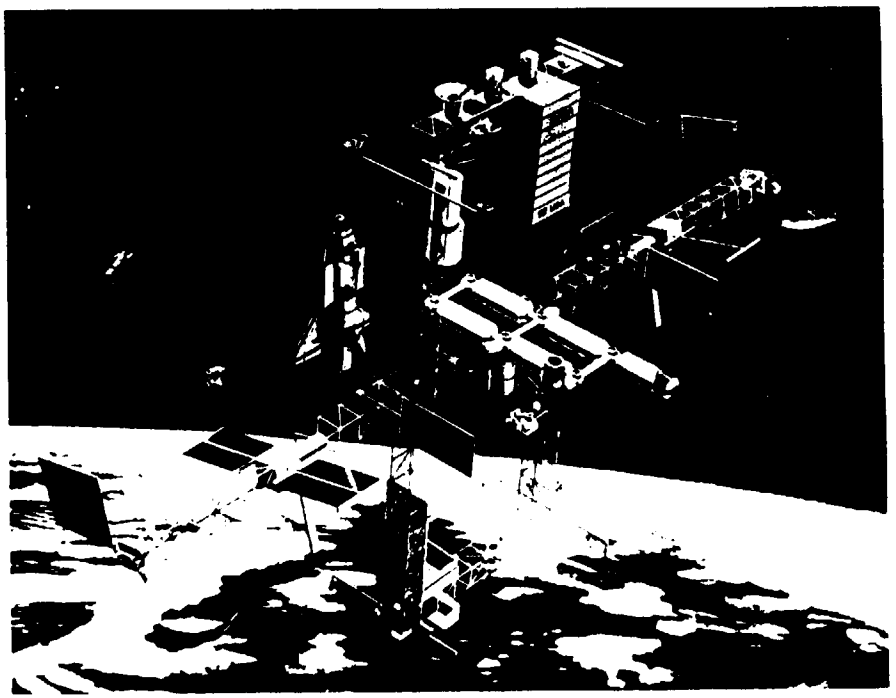
- Critical element of adaptive (autonomous) controls for electrical power systems and components.
- Terrestrial applications can expedite commercialization.

Technologies: High temperature, radiation-hard electronics based on SiC

- Enabling technology for highly reliable and long-lived space based electronics.
- Extensive commercial and military applications.

Intelligent Adaptive Controls Can Improve The Reliability of Space Power Systems

- Minimizing human response time and errors in correcting faults, and properly interpreting fuzzy sensor signals.
- High level autonomous operation
- Detecting incipient faults
- Impact
  - Improved availability
  - Reduced fault severity
  - Reduced maintenance time



The Development of the Product Need, Concept and Implementation Has Utilized Significant University Participation

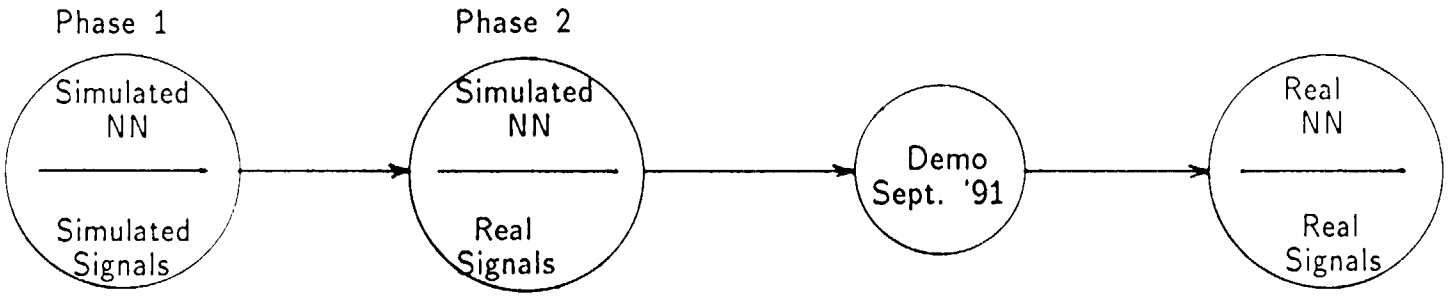
W - STC

- Selection of neural network applications
- Integration of neural network with hardware
- Training of neural network with data
- Laboratory set-up and demonstration
- Commercialization

Auburn U

- Consultation on neural network techniques
- Development of user-friendly neural network software
- Development of parallel processor computer system on card
- Awareness of current developments in neural network hardware and paradigms

Intelligent Fault Protection Development Accompishments and Status



Applied To:	Power System	Power Component (Motor Controller)	Power Source Motor Controller Motor	• (W) Commercialization Maritime Industry • Space Applications • Central Control Systems
Features:	• Proofed concept NN fault classification	• Real-world interface • C-language program (fast) • Realistic input signals • Flexible design choices	• Fault Detector/ Classifier Plug In Board • Real-time response	

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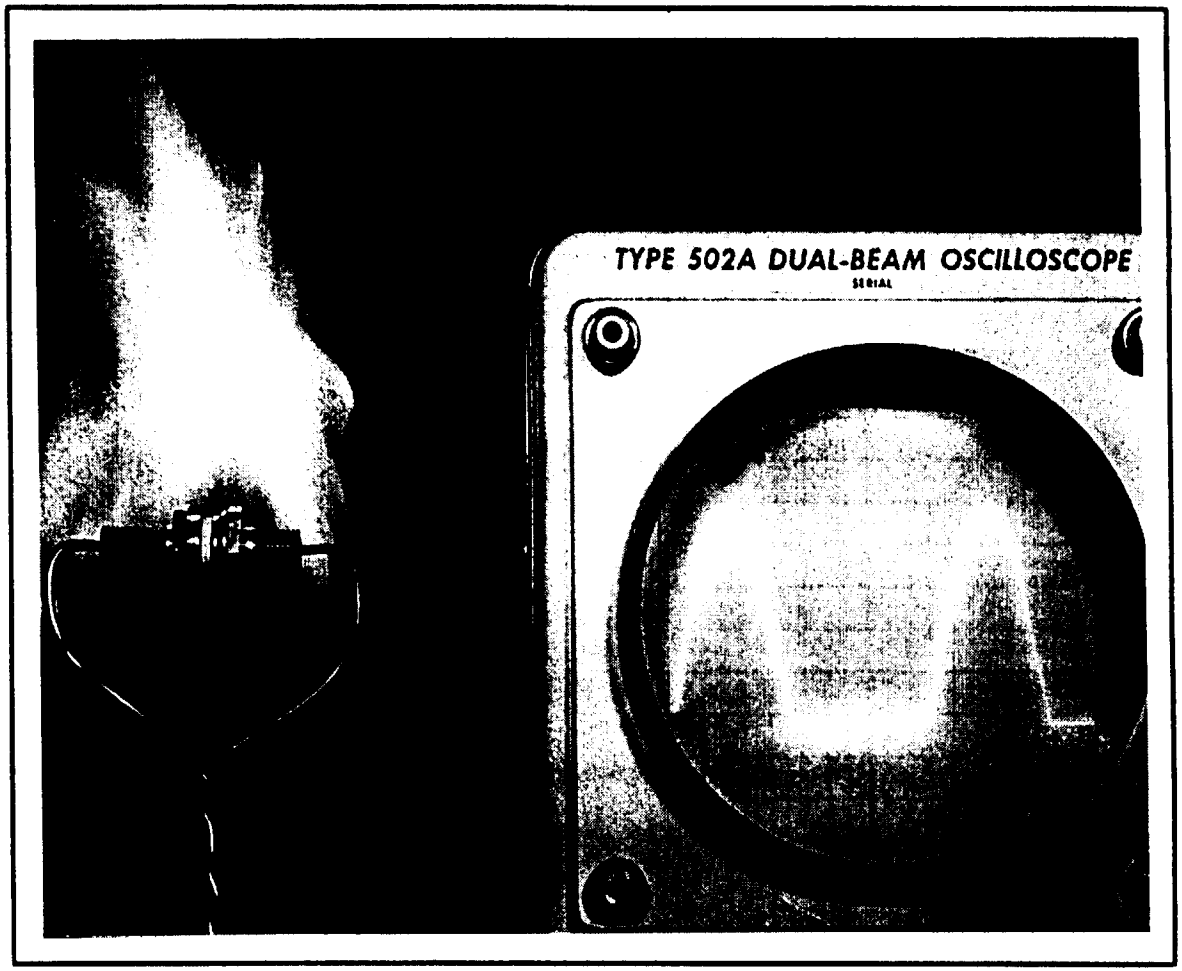
Silicon Carbide (SiC) - The Semiconductor With the Right Stuff

Rectification in a Hot, Chemically Active Environment



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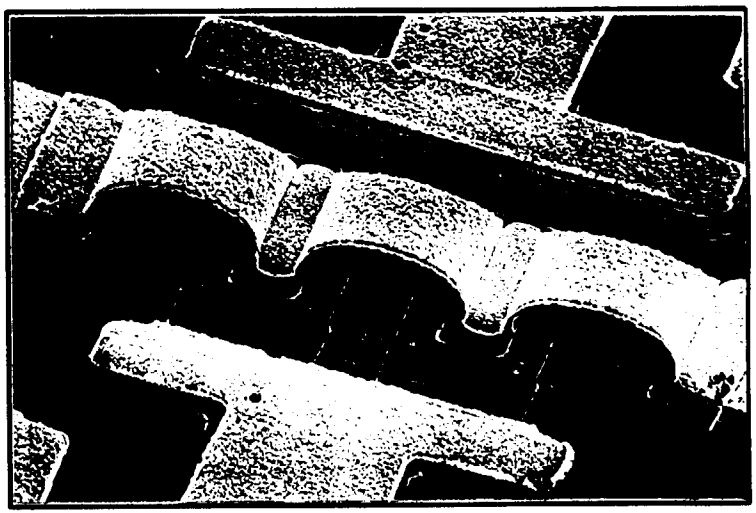
SILICON CARBIDE ELECTRONICS

- High Temperature, RAD Hard Devices are an Enabling Technology for Advanced Ultrareliable Space Electronics
  - Secure, Uninterrupted Satellite Communications
  - Significant Reduction in Satellite Payload Cooling and Weight
  - Compact Reactor Diagnostics and Thrust Controls for SEI Missions



- Silicon Carbide is a Pervasive Technology with Many Commercial Applications

Silicon Carbide Beats Nearest Competitor

High Power

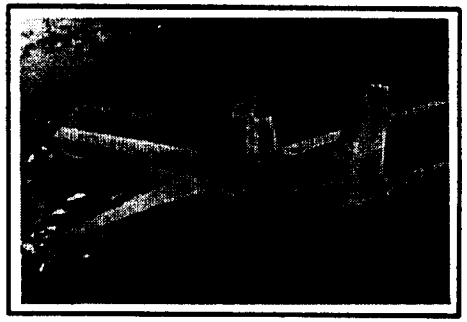
- 10X Power Density
  - Reduced Parts, Size, Cost
  - New Capabilities: Stealth Detection

High Temperature

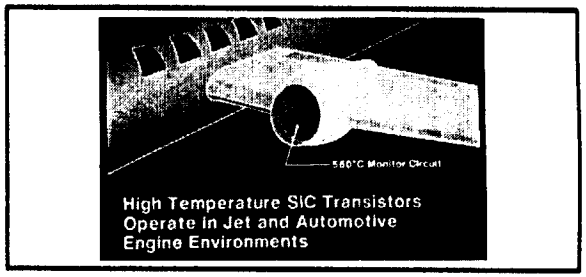
- 650° Operation vs. 150°
  - Less Cooling, Weight, System Cost
  - 1,000X Reliability

Radiation Hard

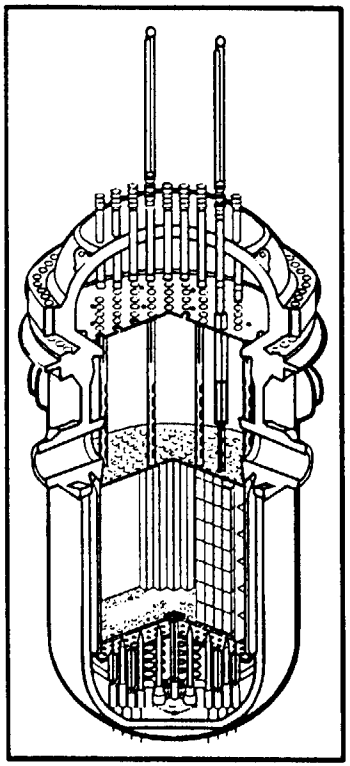
- 20X Gamma, 50X Neutron Resistance
  - First In-Core Electronics for Protection and Control
  - Reduced Cabling, Penetrations and Cost
  - New Services



Transistors for Long-Range Surveillance



Electronics in Severe Environments: All-Electric Vehicles



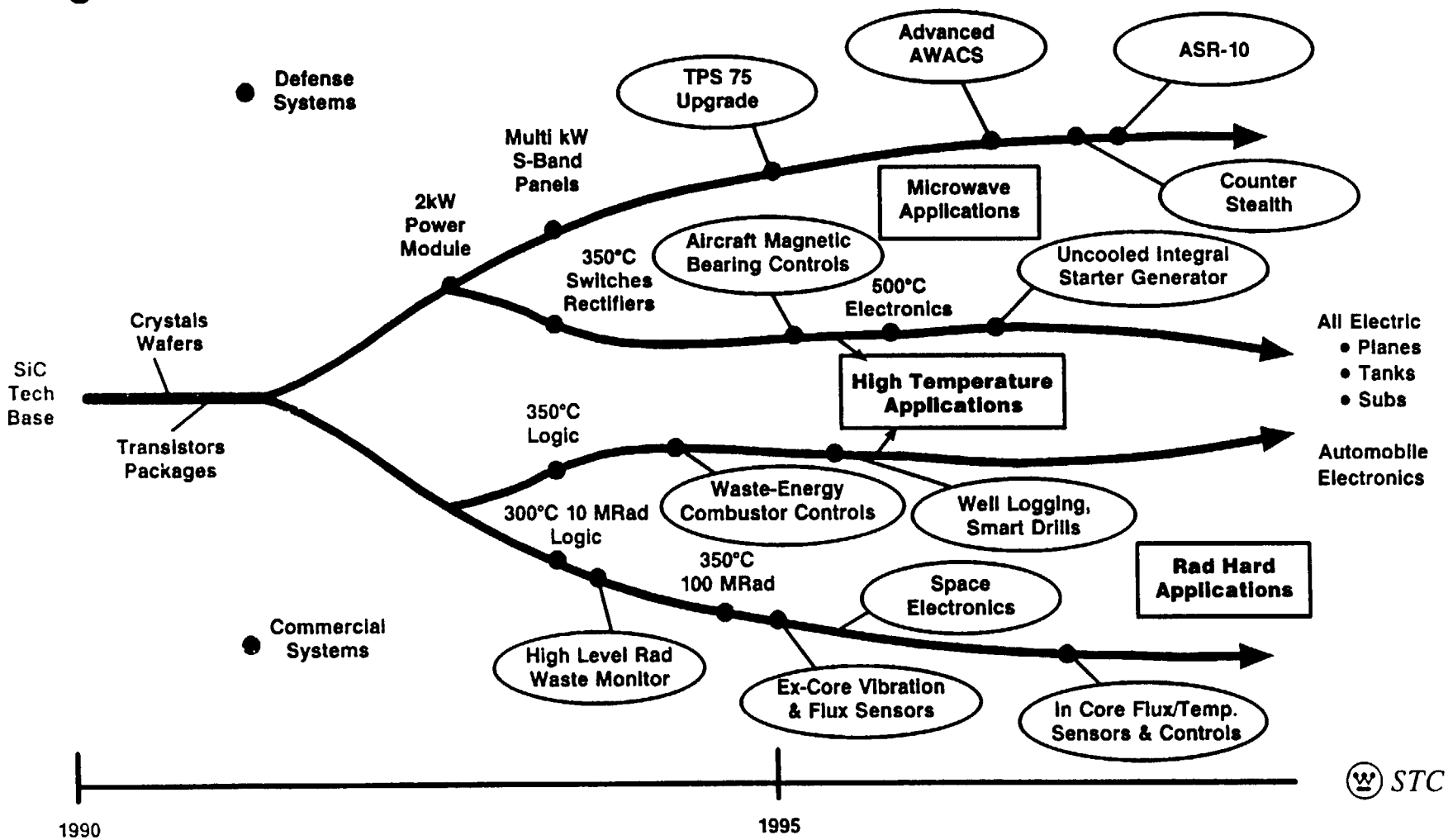
In-Core Flux and Temperature Measurements at 100 MRad 350°

STC

1A620.BW

Silicon Carbide Payoff

Significant New Business



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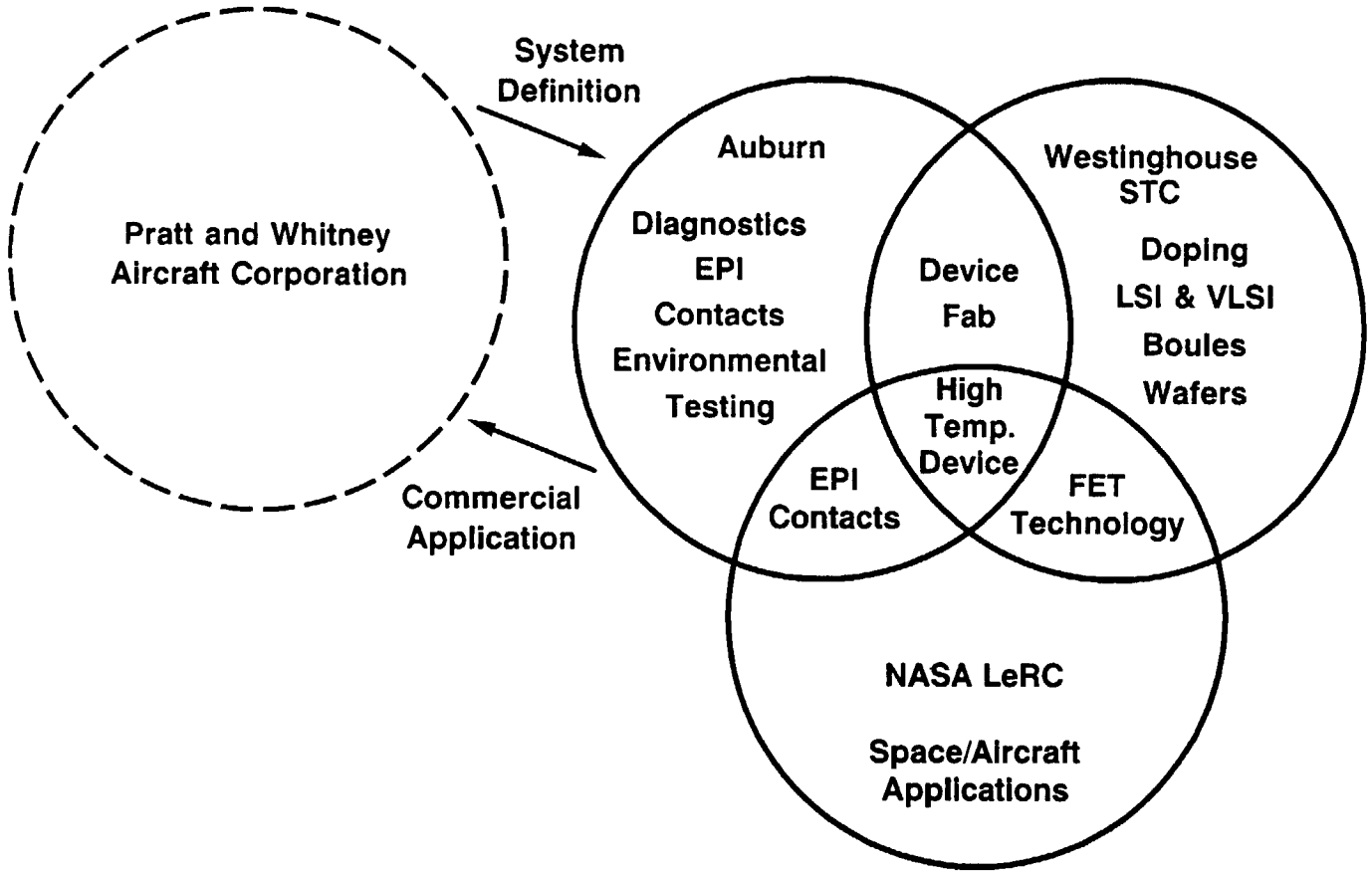
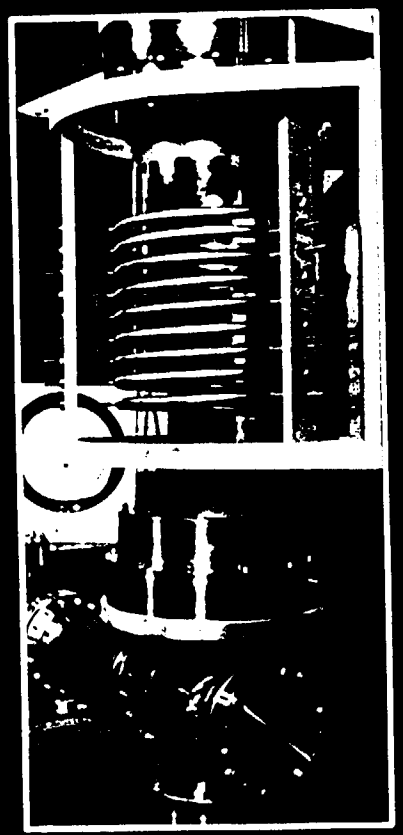
THE AUBURN CCDS PARTNERSHIP

Complementary Skills Linked to Accelerate Silicon Carbide Electronics to Commercialization



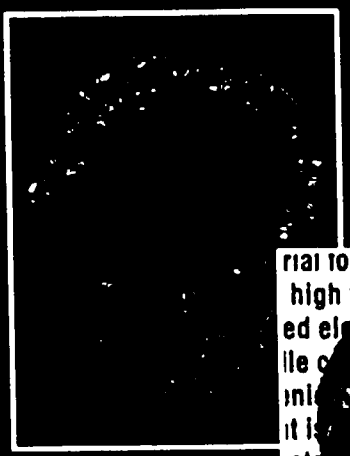
2T501 / VS2561

SiC CRYSTAL GROWTH

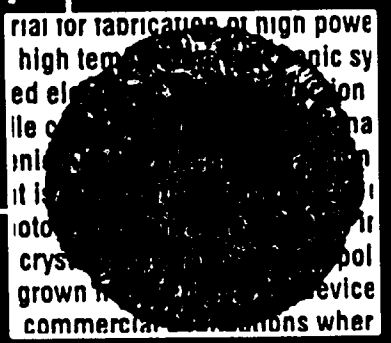


High Purity Growth System

- High Power Microwave
- High Temperature Microelectronics
- Rad Hard Devices



Boule



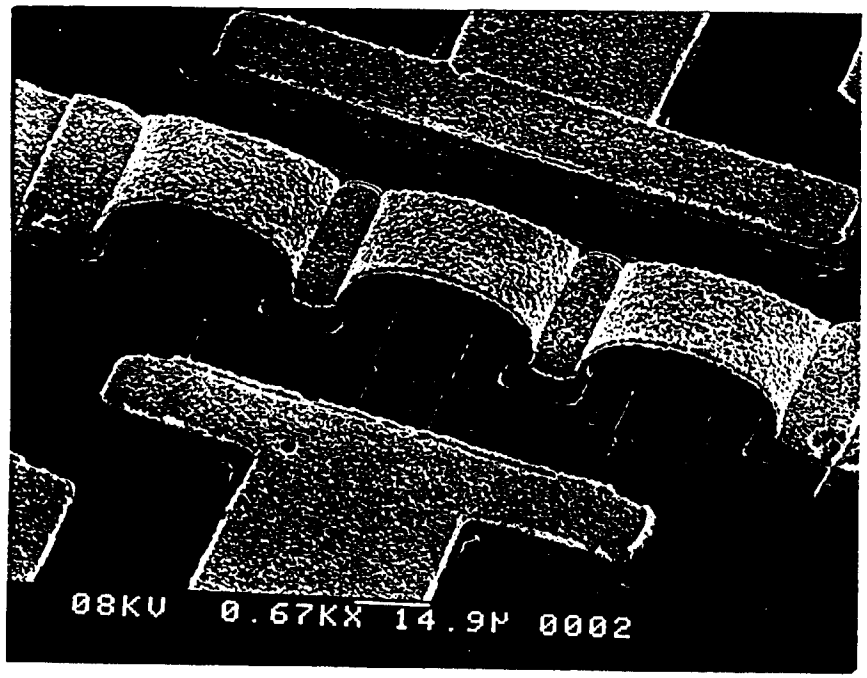
Wafer

Vapor Transport Growth

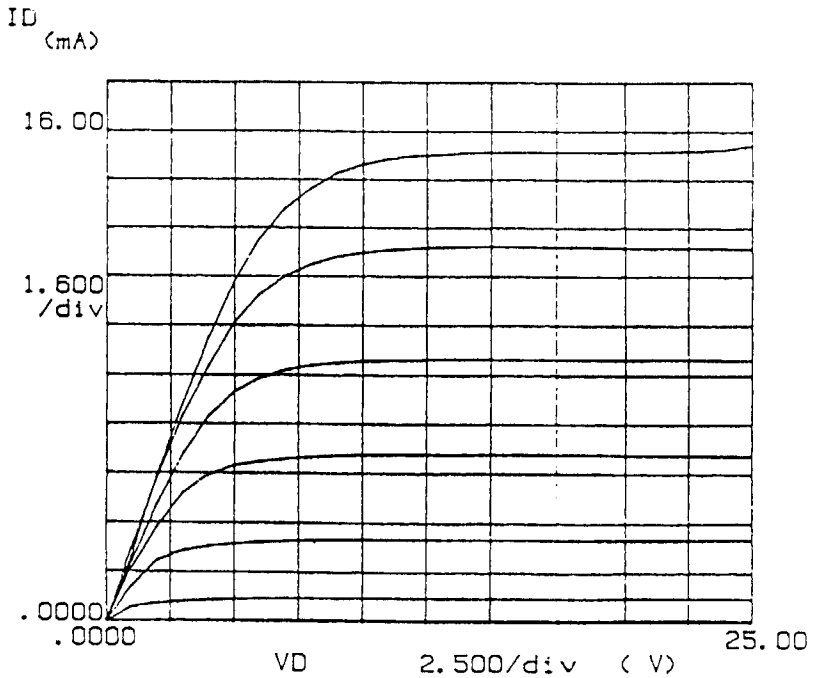
STC

SiC Device Development At STC For Microwave Power Transistors

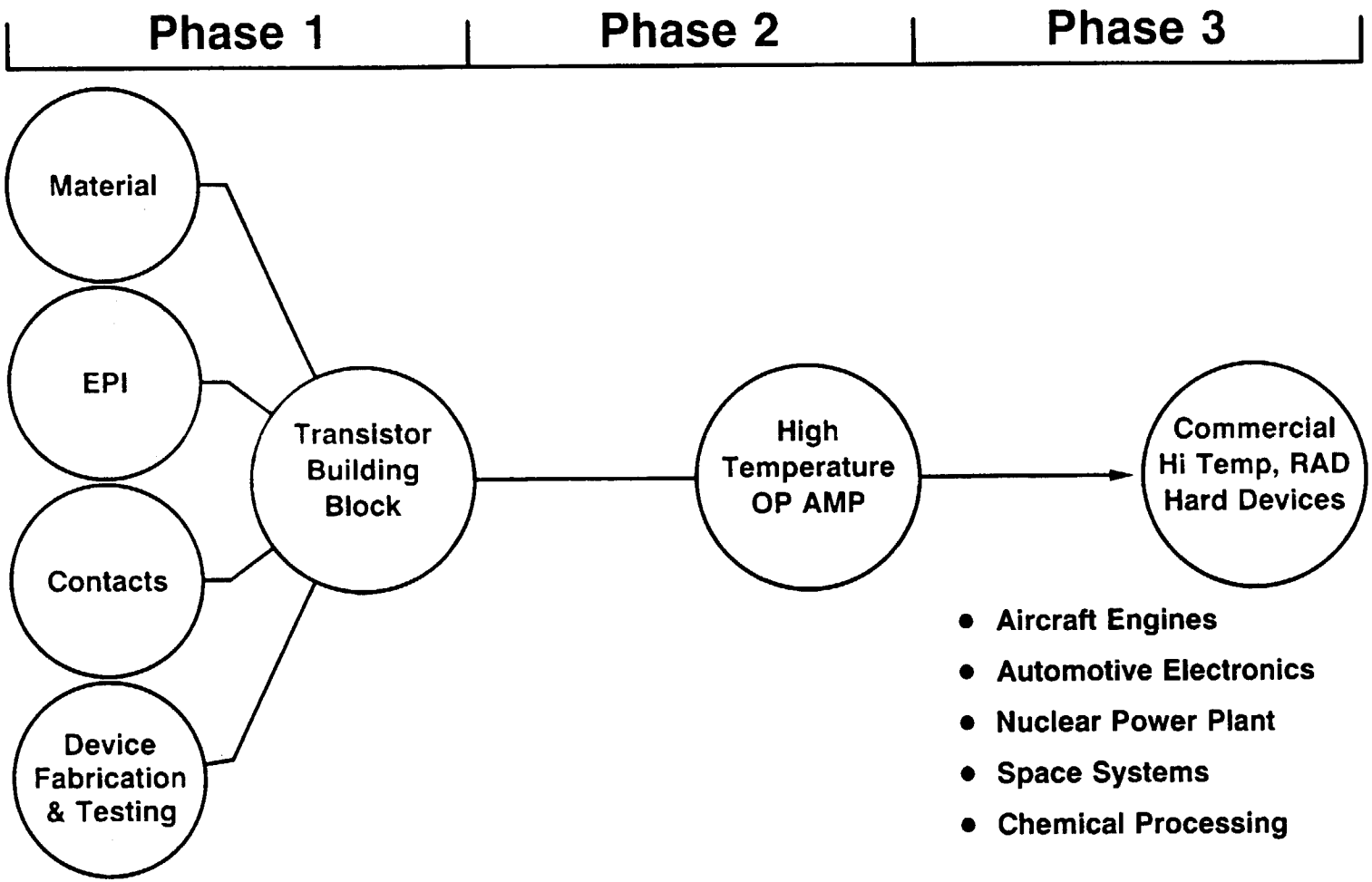
6-Gate μ-Wave Transistor



dc Characteristics



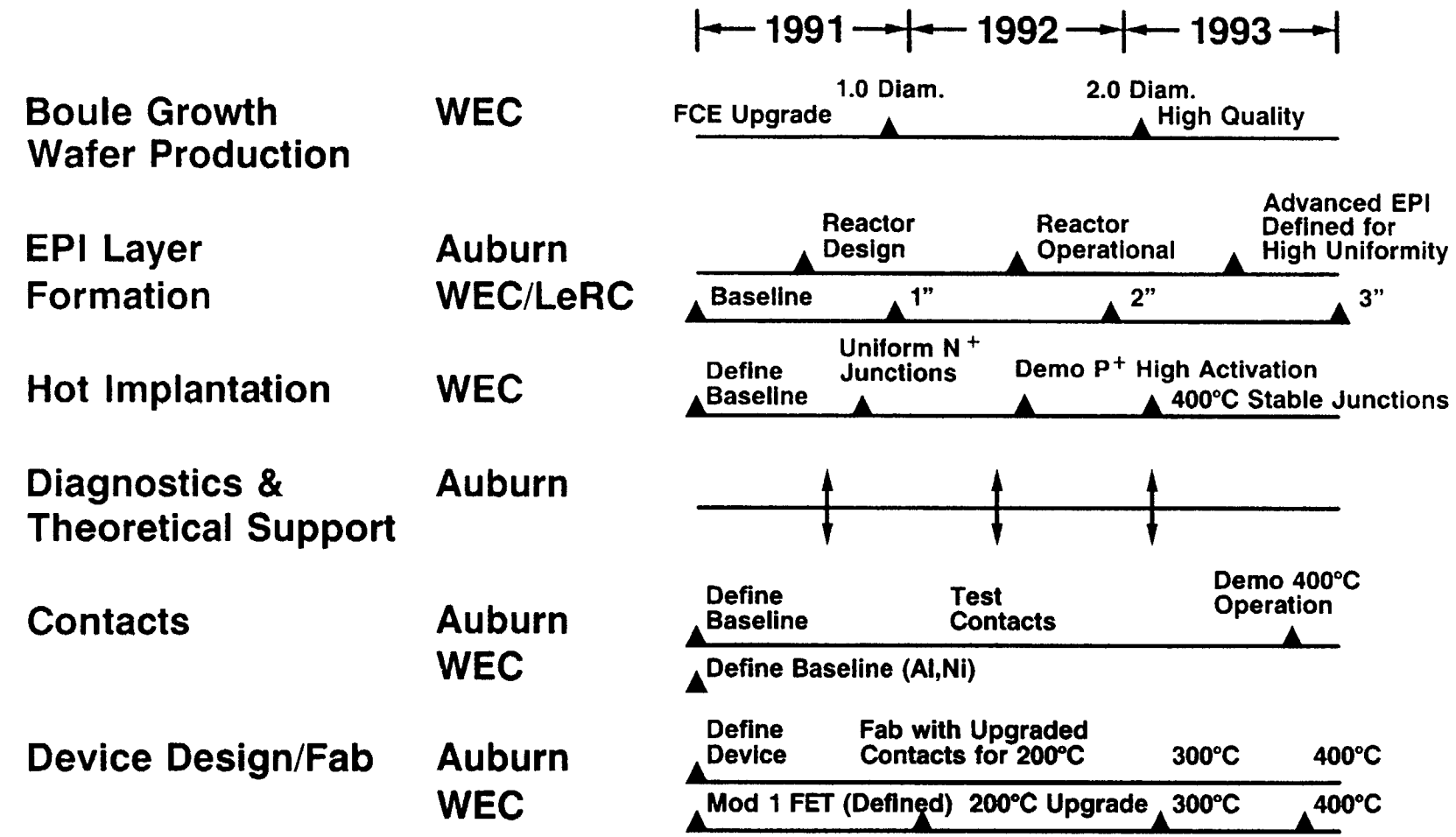
A SILICON CARBIDE MICROELECTRONIC DEVICE DEVELOPMENT PATH HAS BEEN DEFINED



2T502 / VS2561

THE CCDS PROGRAM WAS INITIATED IN 1991

Goal: Devices that Operate at 200-500°C with Acceptable Lifetime



THE CCDS SILICON CARBIDE EFFORT IS ON SCHEDULE

- Working Relationships Established
  - First Exchange of Devices and Test Data Accomplished

	Auburn	Westinghouse
Staff Committed	5 Faculty, 4 Students	6 Scientists, 4 Technical Support
Topics	Structure Modeling Contact Metalization Systems Advanced Epitaxy Techniques SiC Growth Kinetics Surface Chemistry Structural Diagnostics	• Boule Growth Scale-Up • Low Defect Wafer Production • Hot Ion Implantation Junction Formation • Device Design/Fabrication
Status	• RBS Analysis of Initial WEC Contact System • Design of New EPI Reactor Initiated • Polytype Stability Calculations Made	• Furnace Scale-Up Design Complete • Furnace Fabrication Initiated • Sucessful 1.5" Diameter Boule Growth

STC

2T504

The NASA-CCDS at Auburn University Has Met All of Westinghouse's Expectations

- Excellent leadership.
- Impressive R&D programs.
- Stimulation of University environment - participation of students.
- Full cooperation of industrial partners.
- Cooperative participation by government labs.
- Opportunity to develop, in partnership with Auburn University, technologies and components for space.